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EDITOR'S COMMENTS

Presenting the 2018 Fall issue of the *Journal of the Washington Academy of Sciences*.

For this issue we have two papers. The first discusses the intricacies inherit in a standard physics problem for students. Let us drop a ball through a hole in the Earth. How long will it take to reach the other end? Simple? Well maybe or maybe not. The second paper is about the impact authoritarian regimes have on the capacity to think and act critically. Therapists routinely deal with the results of this impact.

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Sethanne Howard

Journal of the Washington Academy of Sciences

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Falling through the Earth

Gene Byrd
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Abstract

One of the problems inflicted on students in introductory physics courses involves an imaginary hole drilled through the center of the Earth. An observer on the surface drops a rock which proceeds to accelerate down the hole through the center of the Earth. There is a deceleration after the rock passes through the center and it just barely makes it to be momentarily at rest at the other end. The total trip is estimated to be about 42 minutes. Of course, the tube should be a vacuum to remove air resistance to the object's free fall *etc*. This paper describes angular momentum/energy complications to the problem as it is usually written. There is a chain of recent articles exploring this problem but with no mention of such objections.

Introduction

ONE OF THE PROBLEMS INFLICTED on students in introductory physics courses, dating back to Isaac Newton, involves an imaginary hole drilled from the observer on the surface through the center of the Earth. Then the observer drops a rock which proceeds to fall down the hole through the center of the Earth. How long does it take before the rock pops up to another observer at the other end of the hole? Now the student has to calculate the gravitational acceleration at each point (at radius r) of the journey due to the mass interior to the rock at each r. Of course, there is a deceleration after the rock passes through the center and it just barely makes it to be momentarily at rest at the other end. And the tube should be a vacuum to remove air resistance to the object's free fall.

While at a faculty meeting discussing how entering students had not solved this problem on a departmental qualifying exam, I thought of some objections to the problem as it is usually written. I dismissed any further action thinking that these objections would be well known to those who have thought more deeply about this problem. At the instigation of your kind editor asking about ideas for an article, I decided to explore published research about this "hole in the Earth" problem. To my surprise, there is a chain of recent articles exploring this problem but with no mention of my objections. This article is a brief review of some aspects of this interesting problem including effects of the complications.

The Earth is assumed to be a homogeneous sphere of matter so the acceleration is just the gravitational constant, G, times the interior mass ($\frac{4}{3}\pi r^3 \times$ density, ρ) divided by r^2 to form the law of gravity. The mass exterior to the rock *does not* contribute to the gravitational acceleration. Dividing by r^2, we see that the net acceleration is proportional to radius. This, of course, is the force law for the harmonic oscillator. Starting from rest the travel time to the other side is 42 minutes.

Recent Discussion

The revival of the topic recently had to do with the proposition that Earth tunnels could be used in a global, fast transportation system of trains (Cooper 1966). Beyond reviewing that a tube drilled straight through the Earth along its diameter would take 42 minutes to fall through, Cooper showed that a straight tube connecting any two surface points could be traversed by a falling object in the same amount of time, independent of distance, and the time could be made shorter with a more efficient path.

In theory a system of trains could travel along minimum-time chord-like tunnels connecting points on Earth. Somewhat grandiosely, Cooper (1966) proposes "By crisscrossing our planet with frictionless subterranean passages man could achieve rapid intercontinental travel comparable in transit time with that of the space vehicle but with no expenditure of energy for locomotion." A text book explanation and historical literature review is given by Kot (2014).

Of course, for the "straight through" problem, modern knowledge of the Earth's hot partially molten center would require walls of an incredibly strong thermally insulating material. Even the shallow chord-like tunnels would present extreme engineering problems.

More recently the discussion was reviewed and mathematically extended by Kotz (2013) adding new a "wrinkle" to the overly idealized original problem. Klotz notes that the Earth is now known to increase in density as one goes into toward the center. Such an increase would change the gravitational force variation with radius and thus change the time required for the trip. It turns out the rock is zipping along at such a rate that by the time it reaches the half-way point to the center the interior density peak structure near the core is not an important contribution to the time. The net result is that the travel time is changed to 38 minutes. Finally, Seel

(2018) included relativity in the calculations, so someday one might fall into other more extreme astronomical objects besides the Earth.

In popular culture an otherwise undistinguished 2012 sequel to the movie, *Total Recall*, features an elaborate free fall transportation system using a tunnel from one side of the Earth to the other. To see a video of this search *YouTube* for *Total Recall The Fall*. It is interesting to critique the physics of this movie.

Energy and Angular Momentum Conservation

In my literature search I was intrigued to see that the complications I had thought about were not mentioned. So, they are presented here. Fundamental physics might mean that the poor rock might not make it through to the other side at all!

What could stop the rock? Conservation of angular momentum and energy could. Drilling the hole at any point on the Earth other than the north and south poles would mean that it has a sideways speed relative to the center of the Earth (even if it is held totally steady before dropping). The gravitational force as it falls is always toward the center (a "central force"). That means the total angular momentum of the falling rock is conserved as it approaches the center. The initial sideways speed, v_i, when dropped, is multiplied by the Earth's radius, r_i to give the angular momentum. As the rock gets closer to the center the sideways speed greatly increases since the radial distance to the center is so much smaller.

Thus, when falling down a narrow hole the magnified sideways speed of the rock would result in its banging against the walls of the hole with serious consequences for the rock. See Figure 1. What if we used an amazingly bouncy superball with similar material for the wall? The ball would bounce back and forth as it descends but it still could not reach the center!
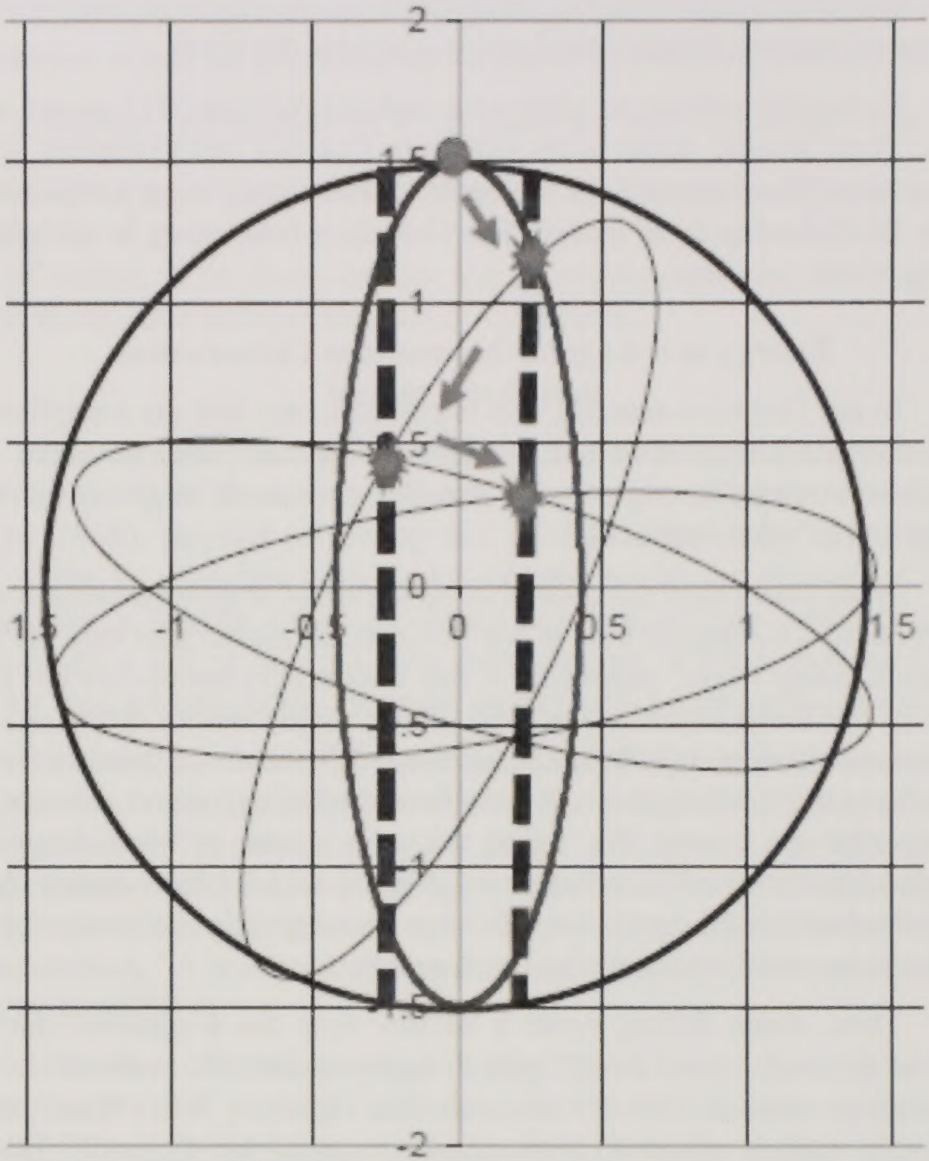
Figure 1 –Schematic path (oval and arrow) of a ball falling into 0.5 unit wide hole from the surface of a uniform density gravitating sphere with an initial transverse speed of 1.2 parallel to the surface. The surface of the sphere is a solid circle. The edges of the hole are shown as dashed lines. The acceleration = 8 r, the harmonic oscillator law for the uniform sphere. Note that the width is insufficient for the ball to make it straight past the center. The initial location is a small dark disk. Several subsequent collisions with the wall are shown as small multipoint stars with arrows between. The oval paths that the ball would follow if it was unimpeded are shown for the initial path and then after each collision.

Instead, the ball would reach a minimum distance from the center as determined by the initial angular momentum and conservation of energy. It would then start receding from the center. Our superball would bang-bang-bang against the sides to close approach then start receding back up the hole. The person who dropped the ball would be surprised to see the ball reappear at the top of the hole where it was dropped about 42 minutes before! A person at the other end would be disappointed with no ball appearing. The minimum distance determination is described at the end of the mathematical **Appendix I**.

What if one dropped the ball at a hole drilled from the North to South Pole? The point to remember is that any sideways perturbation is magnified upon approach to the Earth's center. Even if the Earth were perfectly spherical and the ball had no initial velocity, there could still be problems. Technically, the Earth's Moon would have to be eliminated since the two orbit one another. In addition there are tidal effects from the Sun.

Getting Past the Center

Because of dissipation a bouncing ball could wind up going through the center but with decreasing amplitude, never getting back to the surface. Another alternative would get past the center to reach the other side with no collisions against the walls. As described in the mathematical **Appendix I**, if we assume a narrow shaft, a ball with an initial sideways speed of only 2.5 millimeters per second will be stopped and bounce back at a distance from the center of 2 m. This is about the speed of a slowly crawling snail. One could get the ball to fall through by making the hole sufficiently wide, over 2 m for our example. One would have to be really careful to minimize the initial angular momentum velocity and make the hole sufficiently wide. See Figure 2 for an exaggerated example.

Conclusions

It is not likely that such a tunnel will ever be constructed in the near future, but the concept serves a useful teaching role in introductory physics. Aside from considering how specify a problem, we see that students can not only discover the harmonic oscillator equation but also study conservation of angular momentum and energy in a slightly perturbed system. Students could discuss elaborations. What if the ball was instead a bullet exactly filling the hole with friction-free lubrication? If the bullet had a passenger compartment, what would the passenger feel after entering during the trip?

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Alexander R. Klotz 2013 "The Gravity Tunnel in a Non-Uniform Earth" http://arxiv.org/abs/1308.1342v1

Also see this article in *Discover* magazine for a popular discussion of Klotz's work

http://discovermagazine.com/2016/nov/journey-through-the-center-of-the-earth

Kot, M. 2014, *A First Course in the Calculus of Variations*, American Mathematical Society pp 5, 18. A link is https://books.google.com/books?id=UBi8BAAAQBAJ&lpg=PA5&dq=scientific%20american%20tunnel%20trains%20through%20the%20earth&pg=PA6#v=onepage&q=scientific%20american%20tunnel%20trains%20through%20the%20earth&f=false

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Mathematical Appendix

Conservation of angular momentum and conservation of energy can assure that the dropped rock or ball even with a small initial transverse velocity will not make it through the center of the Earth. The hole should be small compared to the size of the Earth. Indicate with the subscript "m" the variable's value at minimum distance from the center reached by the ball in the shaft. The subscript "i" indicates the initial variable value. At any point the force per unit mass, $f =$ the gravitational constant, G, times the interior mass, $(\frac{4}{3}\pi r^3 \times$ density, $\rho) / r^2$.

At closest approach to the center, the purely transverse speed is v_m and the kinetic energy per unit mass, KE_m is $\frac{1}{2}v_m^2$. When the ball is released at the surface, $KE_m \gg KE_i$ so we can drop KE_i. We do the same for $r_i^2 \gg r_m^2$

The change in the kinetic energy, moving from the initial value of r to the minimum value of r:

$$\frac{1}{2}v_m^2 - \frac{1}{2}v_i^2 \approx \frac{1}{2}v_m^2$$

$$= \int f dr = G\frac{4}{3}\pi\rho \int r dr$$

$$= \frac{1}{2}G\frac{4}{3}\pi\rho\left(r_i^2 - r_m^2\right) \approx \frac{1}{2}G\frac{4}{3}\pi\rho\, r_i^2$$

Recall that angular momentum is conserved between the initial and closest approach. $v_i r_i = v_m r_m$. Solving for v_m and substituting in the KE change above, we obtain:

$$r_m^2 = v_i^2 / \left(G\frac{4}{3}\pi\rho\right).$$

The ball will not be able to cross this minimum distance as it bounces its way toward the center. Upon reaching the minimum the ball then recedes and, with no dissipation, will go outward to the initial radial distance.

Here is an example of the initial transverse minimum velocity resulting in a given closest approach distance $r_{.m} = 2\,\text{m}$. From the equation above we obtain

$$v_i^2 = r_m^2 \left(G \frac{4}{3} \pi \rho \right) \frac{r_i^3}{r_i^3}$$

$$v_i = \frac{r_m}{r_i} \left(\frac{GM}{r_i} \right)^{1/2}$$

Substituting

$M_{Earth} = 5.972 \times 10^{24}$ kg, $r_i = 6.378 \times 10^6$ m and $G = 6.674 \times 10^{-11}$ mks gives $v_i = 0.002477$ m/s. This is about the speed of a slowly crawling snail.

Bio

Gene G. Byrd is a professor emeritus in astronomy of the University of Alabama. He has authored several books and even more professional papers in dynamics of galaxies and lately in dark energy.
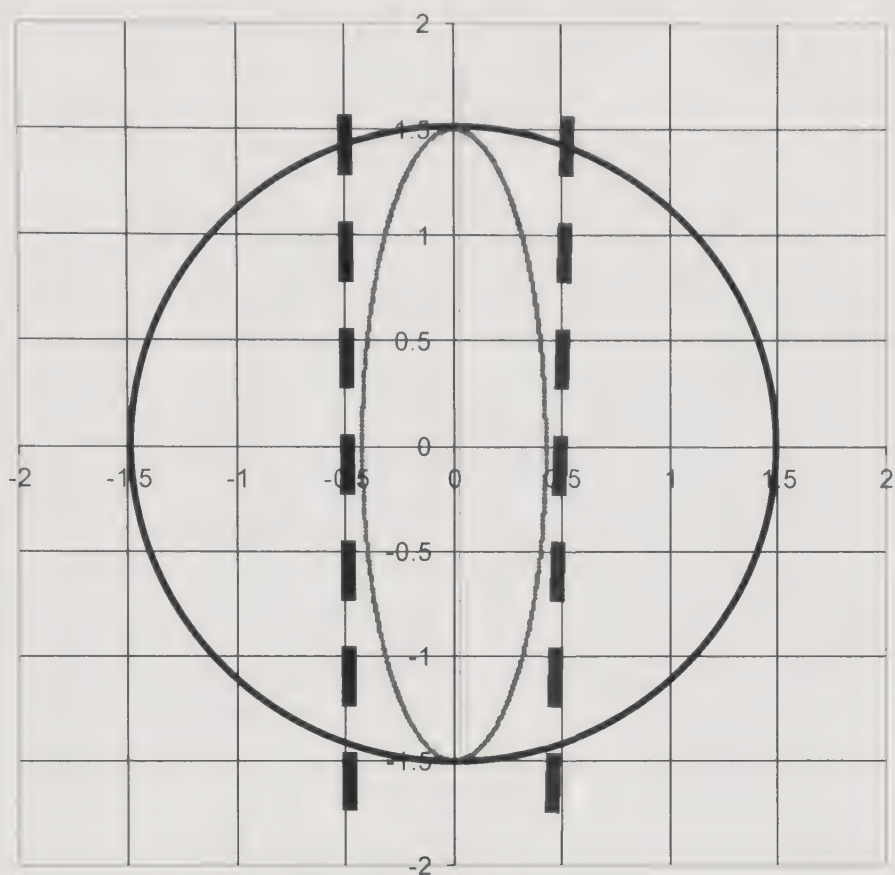
Figure 2 –Schematic path of a ball falling into 1 unit wide hole from the surface of a uniform density gravitating sphere with an initial transverse speed of 1.2 parallel to the surface. The surface of the sphere is a solid circle. The edges of the hole are shown as dashed lines. The acceleration = 8 r, the harmonic oscillator law for the uniform sphere. Note that the width is sufficient for the ball to make it past the center.

The Impact of Authoritarian Regimes on the Capacity to Think and Act Critically[1]

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Abstract

The progression of political powers toward authoritarianism orients a sizable segment of the population not only toward obedience but toward denial of the oppressive nature of their submission, the beginning of a slippery slope that starts with experiencing the imposed nature of the oppressive rules to then adopting them a-critically to finally denying both the internal and external evidence of their existence. To prevent that loss of freedom of thought, speech, and action it becomes imperative, when totalitarianism in any of its versions looms on the political and personal horizon, to preserve the critical capacity to speak and to rebel against any oppressive injunction in order to prevent a self-censoring conceptual and pragmatic adaptive constriction, with dire ethical implications. It is equally important to help those already caught in a self-censoring worldview to recover the words and the capacity to think and act critically lost in their previous experiences.

Introduction

LAST YEAR A SWEET OLD LADY, Brunhilde Pomsel, died in Munich at the age of 106. She was an ordinary person who in her youth had joined the cheering crowd in Berlin that brought Hitler to power in 1933. Soon after she obtained a position as a clerk in the government bureaucracy, and, more by happenstance than by intent, ended up becoming the personal secretary to Joseph Goebbels, minister of Propaganda of the Nazi regime. She would answer his phone, take dictation, record his remarks, and even alter German casualty accounts so that Goebbels could present to Hitler a falsely rosy picture of the progress of the war.

After the conflagration she lived anonymously for most of her life until discovered a few years ago by a journalist and filmmaker, who interviewed her and recorded her musings. Among her comments "I didn't

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know, <u>we</u> didn't know anything on the matter of the Jews (in reference to the Holocaust, the assassination of six million Jews by the Nazi regime). We knew about Buchenwald (one of the hundreds of Nazi concentration/extermination camps, this one located near Weimar, in Germany), but I thought it was an intermediary rehabilitation camp and then the Jews would be transported to and relocated in the Sudetenland." (*The Washington Post*, 2017; parenthesis by the author of this article.)

I believe her, in the sense that I believe in her having fallen into the trap of an official discourse that mandated selective perception and a-critical thinking that punished dissent. Resonating with Goldenhagen's (1997) powerful indictment against the protestation of *ex post facto* ignorance of atrocities of the regime by the ordinary German citizen during that period, I believe that a part of the civilian population in Germany and Austria, living under a repressive regime and exposed only to the official discourse – that obfuscated the "final solution" agenda while maligning its victims, among many externalizations, omissions and distortions – simply managed not to know what they didn't want to know, a sometimes willful, frequently unconscious ignorance that allowed them only to confirm their beliefs and black out the rest. We can do horrible things to our minds when we are under the dome of authoritarian, totalitarian regimes.

Worrisome Times

I wish to add a personal vignette. In 1983 three months after the first democratically elected government replaced a dictatorial military *junta* in Argentina, I was scheduled to deliver a keynote at a family therapy congress in that country. Given the momentous occasion, instead of talking about the subject that I had originally submitted for the program (something about family and schizophrenia, I believe), I presented and discussed a moving and politically charged family consultation I had conducted several years before with a family victimized by the prior dictatorship, including the disappearance of two of its members, a minuscule part of the 15,000 to 30,000 *desaparecidos* abducted, tortured, and killed during the "dirty war" unleashed by that bloody regime. As the presentation progressed (it became clear during the discussion that followed it), a sizable number of the 500 mental health professionals who constituted the audience reacted with extreme alarm. Their first thoughts were "Carlos is crazy! He is putting us all at risk!" and their first reaction was to locate the exit doors of the

conference hall "just in case," see whether other attendants were starting to leave in order to do the same, and so on. It took some time for them to realize that they were reacting to a peril that was no longer there, a remnant of having lived under a mantle of a repression that had already ended. In the discussion that followed the presentation that realization generated an outpour of emotions –many colleagues were crying in a mixture of guilt and relief, and the discussion became a confessional of sins of omission, needs to repair and, indeed, of disclosures by many colleagues who almost subversively had helped families dismembered in one way or the other by the prior regime (for a detailed discussion of that interview and its multiple effects, cf. Sluzki 1990, 1997).

Another, even more personal, vignette is in order. A couple of months ago, while e-mailing a note to a friend at my home office in DC, I discovered myself worrying about whether it would be safe for me to write an anti-Trump political comment by e-mail. Please notice: I am a U.S. citizen, a pacifist, I have lived in the U.S. for 46 years, taught in American academic venues for decades, *et cetera*… but I am not US-born, and therefore I am, literally speaking, a foreigner. What if some agency of the administration is scanning all emails and confectioning a list of people deemed contrary to the regime? Would my family or I be in danger at all? Could my citizenship be revoked and I be expelled from the U.S.? Was I being paranoid, or could this until recently not too long ago gentle if not indifferent governmental apparatus really turn against me?

However, a second-level layer of concerns, triggered by that moment of doubts (of paranoia?), alarmed me more: What if I yielded to those concerns and began to self-censor my own emails, and then my phone conversations, and then my conversations with others, "just in case"? Would I have continued to slide in that slippery slope and cease talking about politically risky subjects first in public, then with friends, and finally with anybody, and then, just as an almost unavoidable follow up effect, censor my thoughts, and, just to clamp the precaution, deny my perceptions, beginning not to see or hear things that are there to be seen and heard and induce outrage?

The polarizing discourses and embedded threats for critical thinking of authoritarian governments aim at undermining our participation in society as free political beings and as professionals: They destabilize if not

erode the values that are the core of our autonomy and solidarity, obfuscate our critical capacity, and contaminate with mistrust our relational world.

These are worrisome times. Far right, ethnic-nationalist, populist, racist, sexist, anti-immigrants, anti-abortion rights, anti-ecological, anti-free speech, post-facts (post-truth!), authoritarian candidates and governments are gaining strength world-wide. We are facing a world being progressively seized by charismatic leaders who may not yet be tyrants with a simplified polarizing discourse capable of perpetrating enormous evil. And, even while many of these ideologies didn't triumph electorally – as happened in some European countries – the effect of their rise has been that majority of the center parties have moved several inches toward social intolerance, as a way of capturing a portion of the electorate attracted by those polarizing discourses.

I am not referring just to the trend toward dismantlement of social entitlements or even the assault on truth, *e.g.*, the blatant use of "alternative facts." Truthfulness has never been counted among the most salient political virtues. To quote Hannah Arendt (from a superb essay titled "Lying in Politics: Reflection on the Pentagon Papers," [1971a], also included in an insightful and increasingly timely collection of essays on politics, violence, civil disobedience [Arendt, 1971b]): "Lies have always been regarded as justifiable tools in political dealings." (1971a, p.30) In her 1963 inquiry into how totalitarian tyrants take hold of people, Hannah Arendt writes: "The essence of totalitarian government, and perhaps the nature of every bureaucracy, is to make mere cogs in the administrative machinery out of men, and thus to dehumanize them." That is the core of what that author called "the banality of evil", a banality epitomized by Adolf Eichmann, a bureaucrat at the center of the development and efficient functioning of the "final solution", who embodied "the dilemma between the unspeakable horror of the deeds and the undeniable ludicrousness of the man who perpetrated them." (Arendt, 1963, p.94)

Governments moving toward totalitarianism expect the citizenry to believe and inhabit the worldview embedded in the official discourse – regardless of their being based on unfulfillable promises and unsustainable distortions — and enforce the adoption of that view through the double-edged sword of rewards and punishment. However, this compliance

endangers if not destroys our ability to be agents of our own lives by contributing to the undermining of our capacity for critical thinking.

In consonance with not-so-veiled threats of punishment for dissent, official discourses tend to be semantically ambiguous: what is asserted doesn't have a base in facts; contradictions and omissions within a given discourse are not clarified but obfuscated; and negative traits and all blame is externalized into the ubiquitous "Other." This ambiguity reduces the critical capacity of whoever is at the receiving end of those messages[2] and increases compliance. In other words, fear activates the down and dirty cognitive navigational system called Type I, the quick, defensive, automatic, stereotypical way of thinking, to the detriment of the slower Type II, the more pondering, complex style of cognition required for critical thinking and retaining curiosity --instead of the quick answers that evade inquiry and sound choices, to sustain concentration instead of dispersion (Kahneman, 2011). Fear – a trigger of Type I mode of thinking – leads to the worst kind of blindness: when "we don't see that we don't see" (von Foerster, 1982).

It merits being noted that, in the short-run, totalitarian discourses elicit in a segment of the audience fervor and elation, just as black-and-white realities resolve doubts, externalize evil, enhance hope, and facilitate a-critical affiliation. This happens through an acceptance of descriptions of reality where social and existential violence is disassociated from the collective self of the faithful and externalized in evil third parties.[3] In turn, in the long run, the oppressive discourse cements in a substantial sector of the general population selective perceptual inattention, disassociations, memory distortions (cf. Langer, 1991), restricted lives, and emotional

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[2] Echoes of the communicational set known as the "double blind," an interactional trap that, when pervasive, elicit pathological responses: contradictory injunctions (at different logical levels) (e.g., "Believe me, even if I am a liar") that require enactment and cannot be simply dismissed, that are elicited by a valued source placed in a position of power, from whom the subject cannot request or obtain a clarification of the contradiction or is punished for attempts to do so; nor can he simply leave the field (Bateson, Jackson Haley & Weakland, 1956; cf. also Sluzki & Ransom, 1976)

[3] This externalization of responsibility also appears frequently in the discourse of rapist, torturers, perpetrators of domestic and even random violence, uttered while enacting the violence with the effect of mystifying agency by blaming the victim for the violence they are suffering: "You were looking for this", "You made me do it", *et cetera* (Sluzki, 1993).

blindness or guilt. Families become plagued with secrets, silences, social isolation and trans-generational splits, and communities become polarized.

In the specific sector of the population to which the author belongs, namely, therapists of one sort or another (psychiatrist, psychologists, counselors), the risk of immersion into the worldview espoused by the totalitarian discourse is a development of blind spots, a distorted capacity for empathy or resonance, a skew toward decontextualization and pathologizing (defining impacts of, or rebellion against, oppression as deviant), becoming, by commission or omission, a cog in the repressive social machine at the service of the authoritarian regime (Sluzki, 1997).

When living bombarded by an official discourse that challenges reality, threatens dissent, and foments polarization, how do we preserve our integrity as individuals and as social advocates; how do we retain our ability to maintain and help others maintain or regain mindfulness, critical thinking and responsible social insertion? And do we do it while meeting anger with compassion, intolerance with tolerance, fanaticism with empathy and social responsibility? The ethical and pragmatic challenge is clear: To be alert to the insidious effects of the messages of repressive regimes, to catch self-censoring constrictions by the tail, preserve self-reflection in our capacity to think critically and maintain our freedom to act accordingly. Ultimately we help individuals, families, and communities recover words and agency and challenge narratives that polarize blaming the "Other" and pathologize or punish disobedience. All this entails retaining and promoting mindfulness and also maintaining active conversations…like the one starting here.

Conclusion

In conclusion there are five key points to remember.

Five Key Points

- The default adaptive mode of submission to an oppressive authority, either by option (*e.g.*, welcoming a leader that promises order after a period of chaos), by fear of the consequences if confronted (*e.g.*, threats of prison, torture, disappearance, or merely imperiled job security) or by indifference, leads to a progressive desensitization and ultimately silencing and blindness to any contradictory evidence.

- This process of surrender of agency buries themes and vocabularies that may contradict that submission. Acts of governmental violence and acts of dissent are erased from perception and from conversation.
- It is our responsibility as citizens (and those who are therapists, as therapists) to defend the integrity of our language and of our mind and our capacity to critically confront oppression (for us and for our patients), so as to counter submission to authoritarianism.
- And when working with people emerging from a period of individual or collective submission to an authoritarian leadership, it behooves us to help them actively to recover their words as a way of regaining a world where agentic power is the rule and not the privileged official discourse.

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Bio

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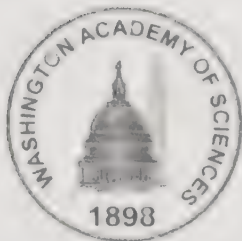
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The John W. Kluge Center of the Library of Congress

Potomac Overlook Regional Park

Koshland Science Museum

American Registry of Pathology

Living Oceans Foundation

National Rural Electric Cooperative Association (NRECA)

Delegates to the Washington Academy of Sciences Representing Affiliated Scientific Societies

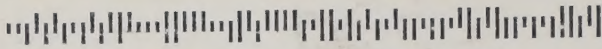|	
Acoustical Society of America	Paul Arveson
American/International Association of Dental Research	J. Terrell Hoffeld
American Assoc. of Physics Teachers, Chesapeake Section	Frank R. Haig, S. J.
American Astronomical Society	Sethanne Howard
American Fisheries Society	Lee Benaka
American Institute of Aeronautics and Astronautics	David W. Brandt
American Institute of Mining, Metallurgy & Exploration	E. Lee Bray
American Meteorological Society	Vacant
American Nuclear Society	Charles Martin
American Phytopathological Society	Vacant
American Society for Cybernetics	Stuart Umpleby
American Society for Microbiology	Vacant
American Society of Civil Engineers	Vacant
American Society of Mechanical Engineers	Daniel J. Vavrick
American Society of Plant Physiology	Mark Holland
Anthropological Society of Washington	Vacant
ASM International	Toni Marechaux
Association for Women in Science	Jodi Wesemann
Association for Computing Machinery	Vacant
Association for Science, Technology, and Innovation	F. Douglas Witherspoon
Association of Information Technology Professionals	Vacant
Biological Society of Washington	Vacant
Botanical Society of Washington	Chris Puttock
Capital Area Food Protection Association	Keith Lempel
Chemical Society of Washington	Vacant
District of Columbia Institute of Chemists	Vacant
District of Columbia Psychology Association	Vacant
Eastern Sociological Society	Ronald W. Mandersheid
Electrochemical Society	Vacant
Entomological Society of Washington	Vacant
Geological Society of Washington	Jurate Landwehr
Historical Society of Washington DC	Vacant
Human Factors and Ergonomics Society	Gerald Krueger

(continued on next page)

Delegates to the Washington Academy of Sciences Representing Affiliated Scientific Societies

Institute of Electrical and Electronics Engineers, Washington Section	Richard Hill
Institute of Food Technologies, Washington DC Section	Taylor Wallace
Institute of Industrial Engineers, National Capital Chapter	Neal F. Schmeidler
International Association for Dental Research, American Section	Christopher Fox
International Society for the Systems Sciences	Vacant
International Society of Automation, Baltimore Washington Section	Richard Sommerfield
Instrument Society of America	Hank Hegner
Marine Technology Society	Jake Sobin
Maryland Native Plant Society	Vacant
Mathematical Association of America, Maryland-District of Columbia-Virginia Section	John Hamman
Medical Society of the District of Columbia	Julian Craig
National Capital Area Skeptics	Vacant
National Capital Astronomers	Jay H. Miller
National Geographic Society	Vacant
Optical Society of America, National Capital Section	Jim Heaney
Pest Science Society of America	Vacant
Philosophical Society of Washington	Larry S. Millstein
Society for Experimental Biology and Medicine	Vacant
Society of American Foresters, National Capital Society	Marilyn Buford
Society of American Military Engineers, Washington DC Post	Vacant
Society of Manufacturing Engineers, Washington DC Chapter	Vacant
Society of Mining, Metallurgy, and Exploration, Inc., Washington DC Section	E. Lee Bray
Soil and Water Conservation Society, National Capital Chapter	Erika Larsen
Technology Transfer Society, Washington Area Chapter	Richard Leshuk
Virginia Native Plant Society, Potowmack Chapter	Alan Ford
Washington DC Chapter of the Institute for Operations Research and the Management Sciences (WINFORMS)	Meagan Pitluck-Schmitt
Washington Evolutionary Systems Society	Vacant
Washington History of Science Club	Albert G. Gluckman
Washington Paint Technology Group	Vacant
Washington Society of Engineers	Alvin Reiner
Washington Society for the History of Medicine	Alain Touwaide
Washington Statistical Society	Michael P. Cohen
World Future Society, National Capital Region Chapter	Jim Honig

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